FIG. 1

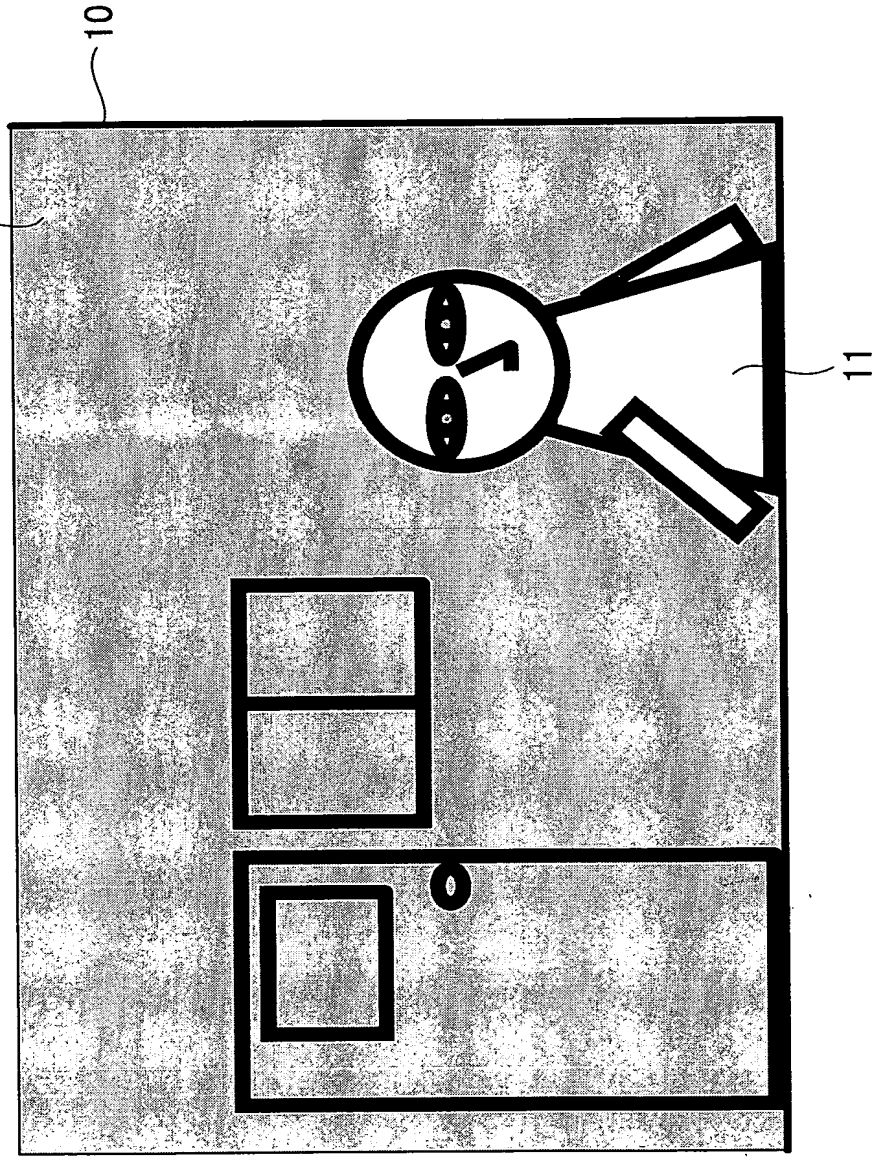

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FIG. 2A

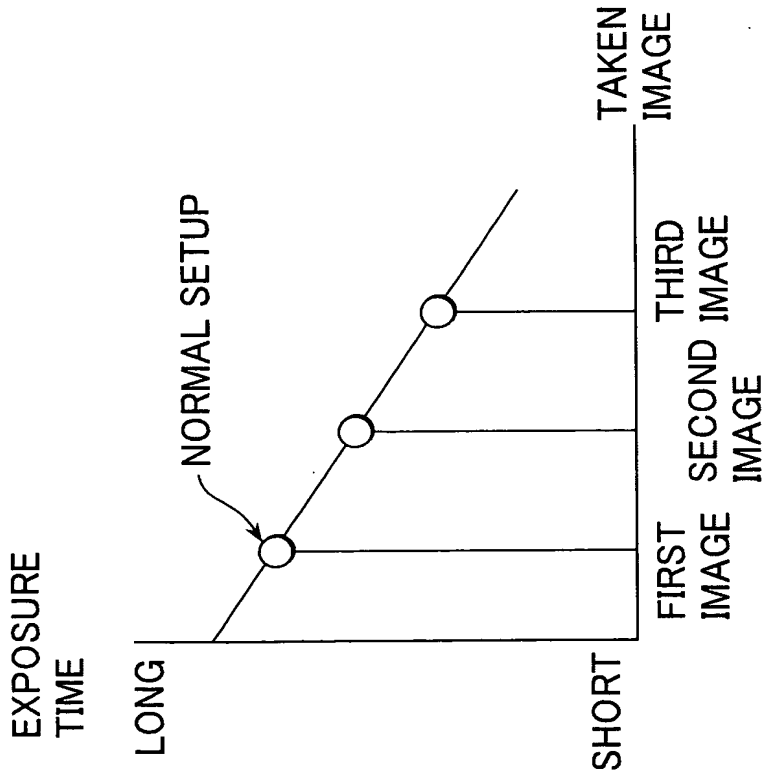

EXPOSURE TIME
LONG
SHORT
NORMAL SETUP
FIRST IMAGE
SECOND IMAGE
THIRD IMAGE
TAKEN IMAGE

FIG. 2B

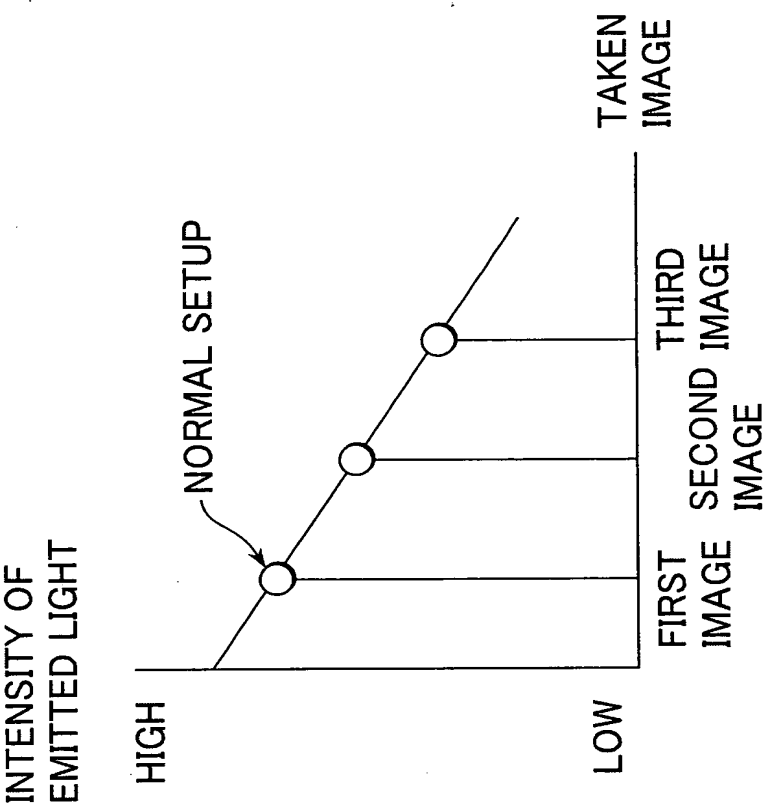

INTENSITY OF EMITTED LIGHT
HIGH
LOW
NORMAL SETUP
FIRST IMAGE
SECOND IMAGE
THIRD IMAGE
TAKEN IMAGE

FIG. 3

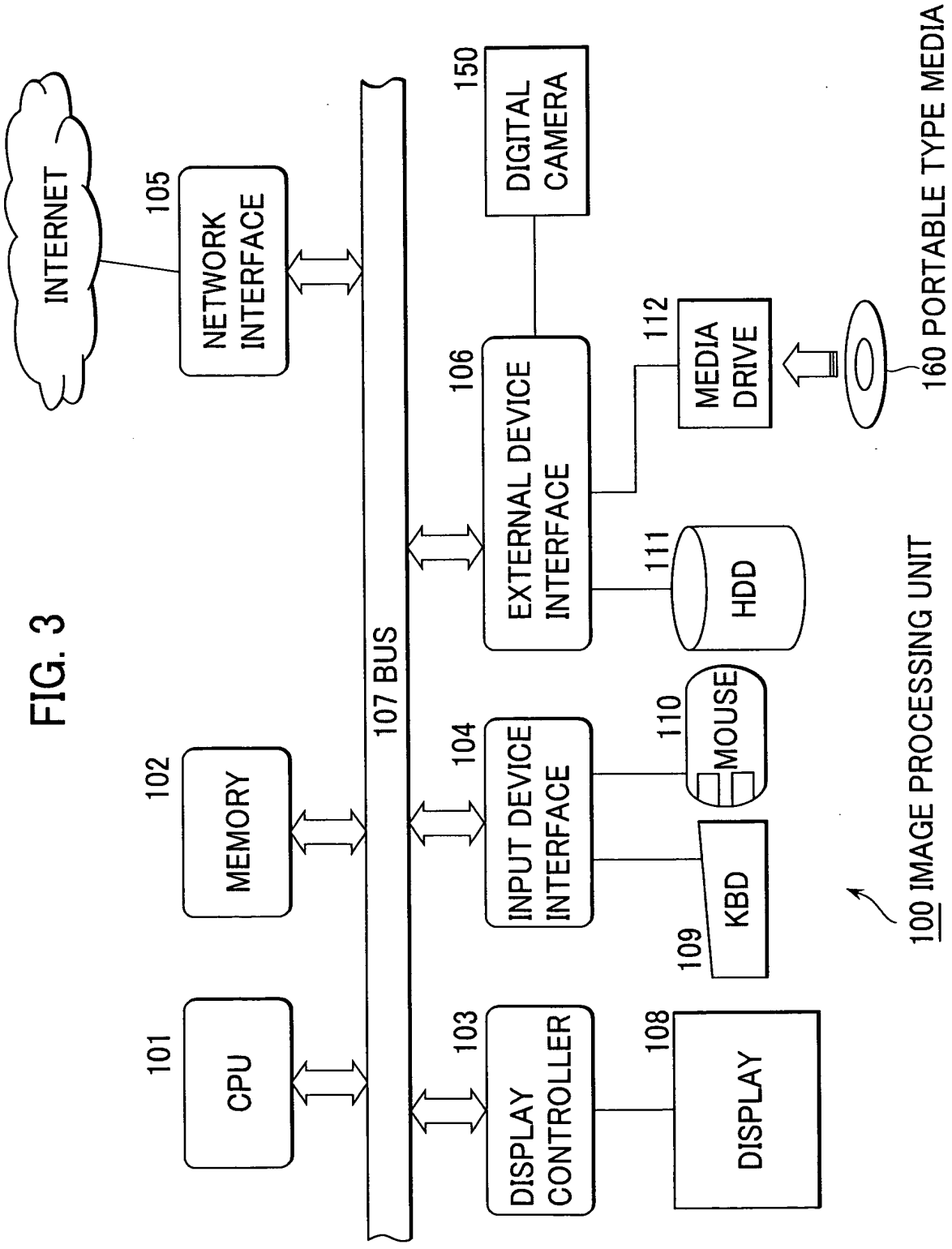
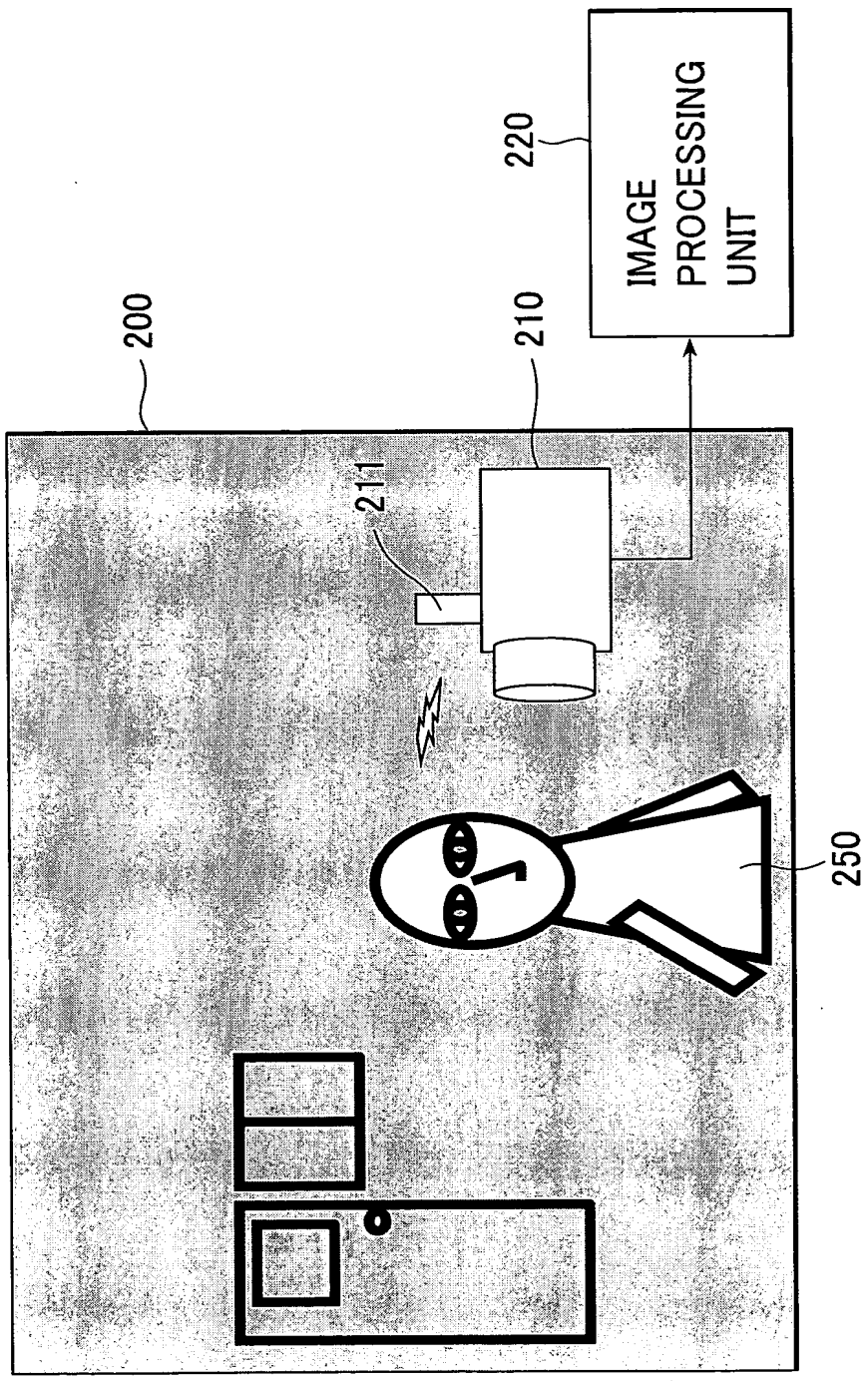

INTERNET
105
NETWORK INTERFACE
150
DIGITAL CAMERA
106
EXTERNAL DEVICE INTERFACE
112
MEDIA DRIVE
160 PORTABLE TYPE MEDIA
111
HDD
107 BUS
102
MEMORY
104
INPUT DEVICE INTERFACE
110
MOUSE
109
KBD
101
CPU
103
DISPLAY CONTROLLER
108
DISPLAY
100 IMAGE PROCESSING UNIT

FIG. 4



BEST AVAILABLE COPY

FIG. 5A

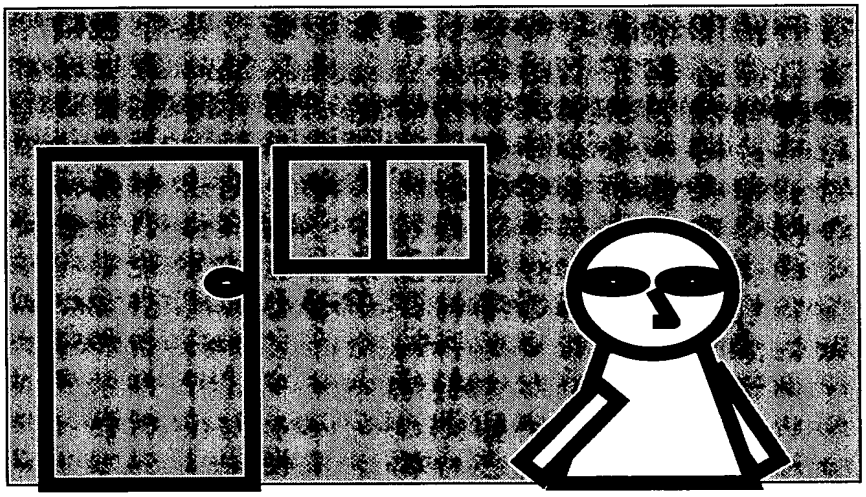


FIG. 5B

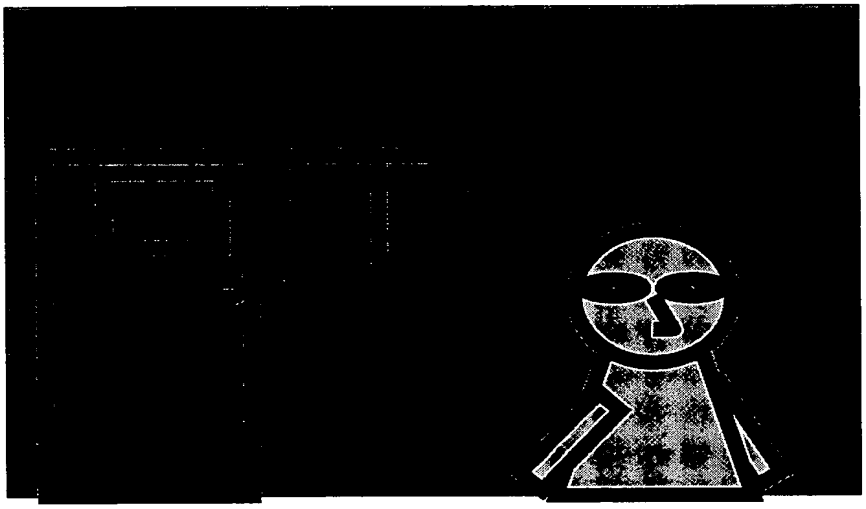


FIG. 5C

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FIG. 6

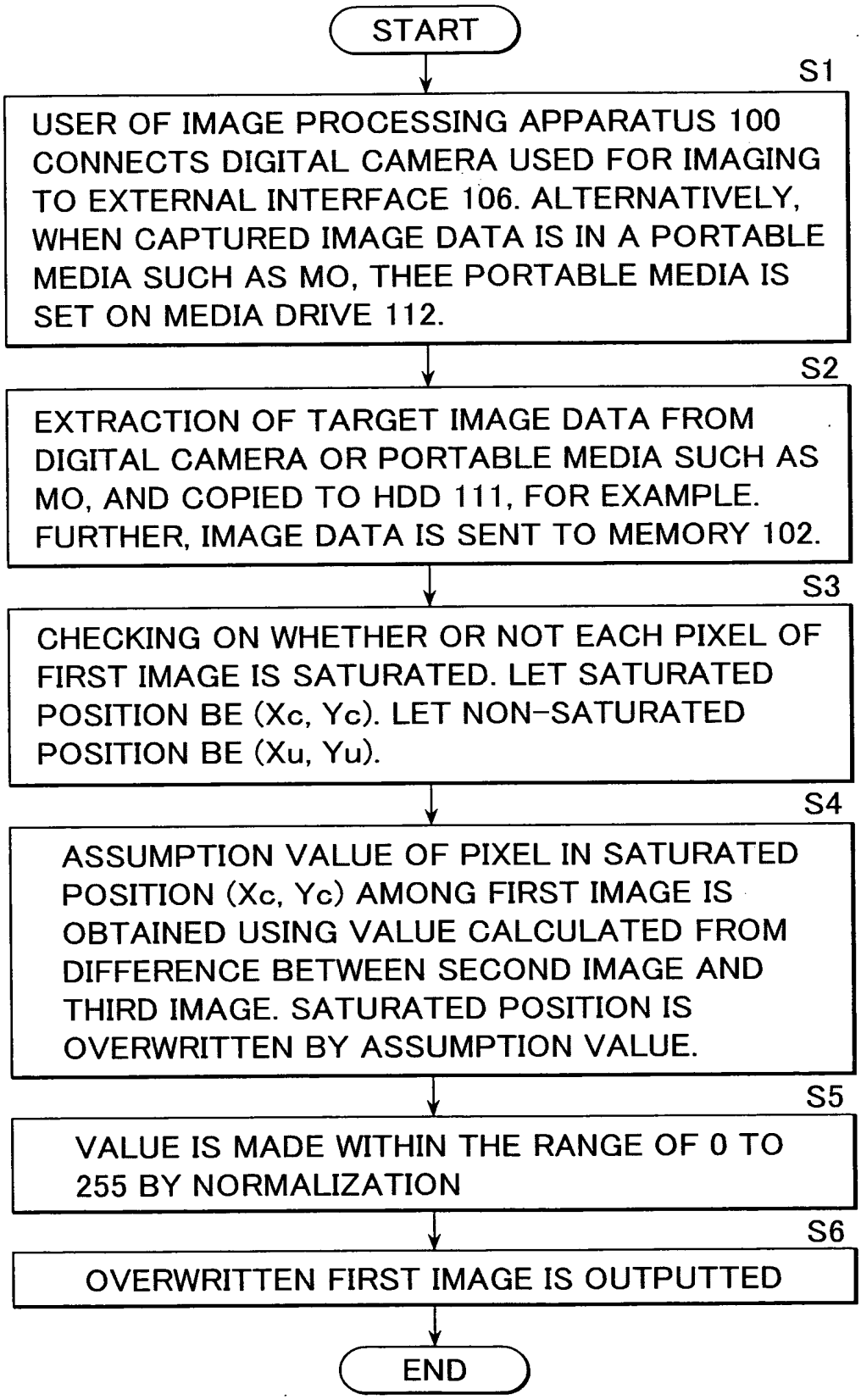

START
S1
USER OF IMAGE PROCESSING APPARATUS 100 CONNECTS DIGITAL CAMERA USED FOR IMAGING TO EXTERNAL INTERFACE 106. ALTERNATIVELY, WHEN CAPTURED IMAGE DATA IS IN A PORTABLE MEDIA SUCH AS MO, THEE PORTABLE MEDIA IS SET ON MEDIA DRIVE 112.
S2
EXTRACTION OF TARGET IMAGE DATA FROM DIGITAL CAMERA OR PORTABLE MEDIA SUCH AS MO, AND COPIED TO HDD 111, FOR EXAMPLE. FURTHER, IMAGE DATA IS SENT TO MEMORY 102.
S3
CHECKING ON WHETHER OR NOT EACH PIXEL OF FIRST IMAGE IS SATURATED. LET SATURATED POSITION BE (Xc, Yc). LET NON-SATURATED POSITION BE (Xu, Yu).
S4
ASSUMPTION VALUE OF PIXEL IN SATURATED POSITION (Xc, Yc) AMONG FIRST IMAGE IS OBTAINED USING VALUE CALCULATED FROM DIFFERENCE BETWEEN SECOND IMAGE AND THIRD IMAGE. SATURATED POSITION IS OVERWRITTEN BY ASSUMPTION VALUE.
S5
VALUE IS MADE WITHIN THE RANGE OF 0 TO 255 BY NORMALIZATION
S6
OVERWRITTEN FIRST IMAGE IS OUTPUTTED
END

FIG. 7

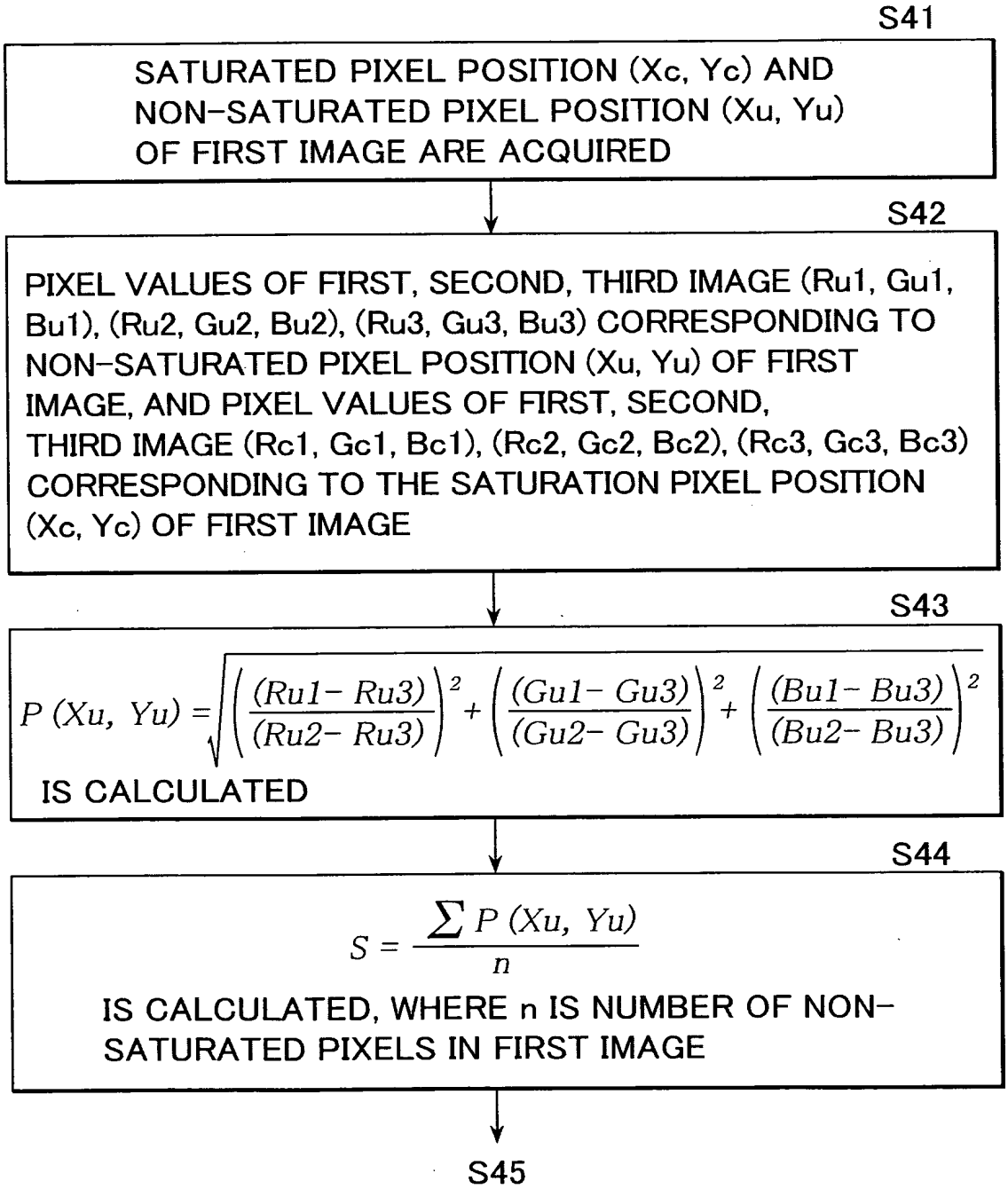

S41
SATURATED PIXEL POSITION (Xc, Yc) AND NON-SATURATED PIXEL POSITION (Xu, Yu) OF FIRST IMAGE ARE ACQUIRED
S42
PIXEL VALUES OF FIRST, SECOND, THIRD IMAGE (Ru1, Gu1, Bu1), (Ru2, Gu2, Bu2), (Ru3, Gu3, Bu3) CORRESPONDING TO NON-SATURATED PIXEL POSITION (Xu, Yu) OF FIRST IMAGE, AND PIXEL VALUES OF FIRST, SECOND, THIRD IMAGE (Rc1, Gc1, Bc1), (Rc2, Gc2, Bc2), (Rc3, Gc3, Bc3) CORRESPONDING TO THE SATURATION PIXEL POSITION (Xc, Yc) OF FIRST IMAGE
S43
$P(Xu, Yu) = \sqrt{\left(\frac{(Ru1-Ru3)}{(Ru2-Ru3)}\right)^2 + \left(\frac{(Gu1-Gu3)}{(Gu2-Gu3)}\right)^2 + \left(\frac{(Bu1-Bu3)}{(Bu2-Bu3)}\right)^2}$
IS CALCULATED
S44
$S = \frac{\sum P(Xu, Yu)}{n}$
IS CALCULATED, WHERE n IS NUMBER OF NON-SATURATED PIXELS IN FIRST IMAGE
S45

FIG. 8

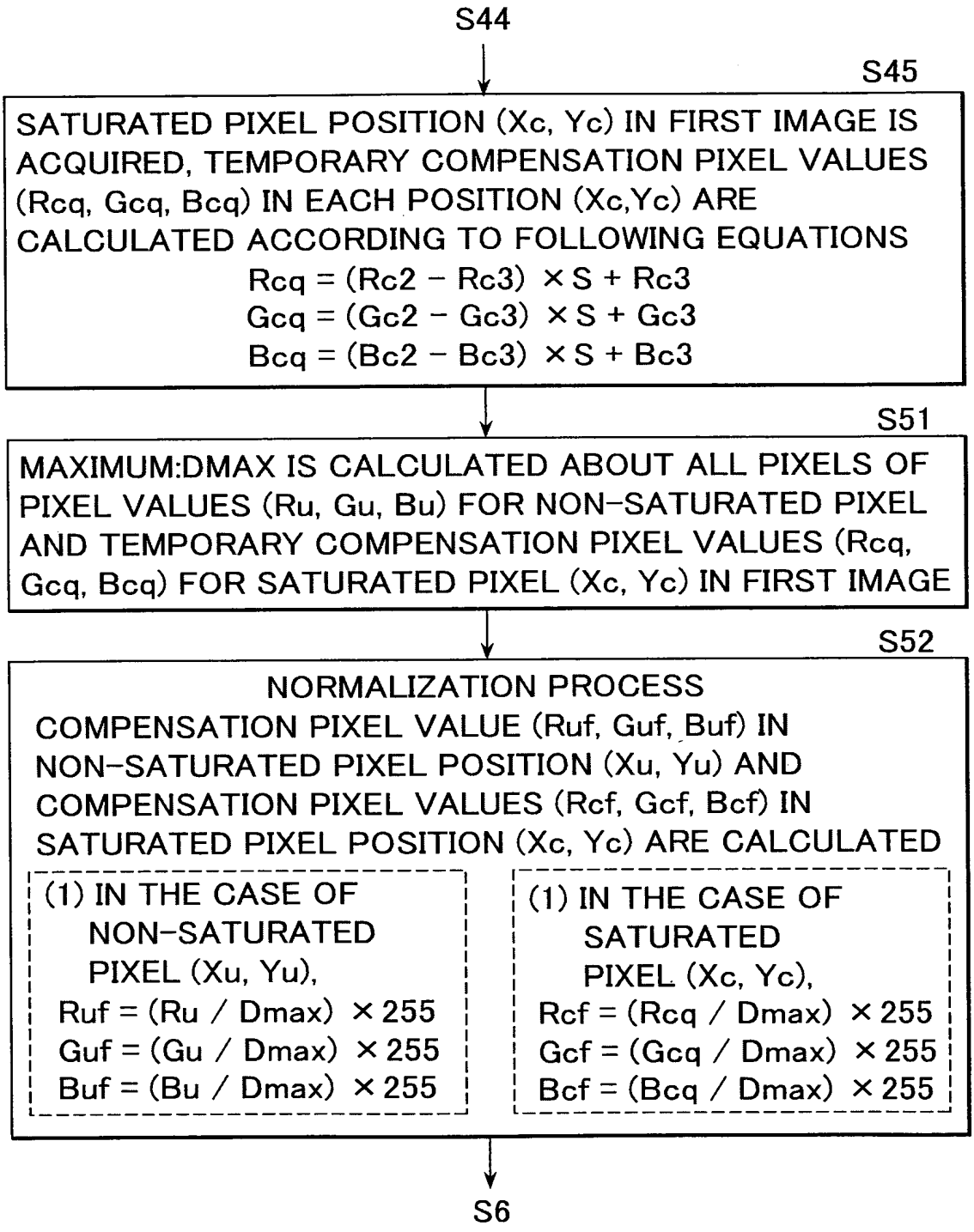

S44
S45
SATURATED PIXEL POSITION (Xc, Yc) IN FIRST IMAGE IS ACQUIRED, TEMPORARY COMPENSATION PIXEL VALUES (Rcq, Gcq, Bcq) IN EACH POSITION (Xc,Yc) ARE CALCULATED ACCORDING TO FOLLOWING EQUATIONS
Rcq = (Rc2 − Rc3) × S + Rc3
Gcq = (Gc2 − Gc3) × S + Gc3
Bcq = (Bc2 − Bc3) × S + Bc3
S51
MAXIMUM:DMAX IS CALCULATED ABOUT ALL PIXELS OF PIXEL VALUES (Ru, Gu, Bu) FOR NON-SATURATED PIXEL AND TEMPORARY COMPENSATION PIXEL VALUES (Rcq, Gcq, Bcq) FOR SATURATED PIXEL (Xc, Yc) IN FIRST IMAGE
S52
NORMALIZATION PROCESS
COMPENSATION PIXEL VALUE (Ruf, Guf, Buf) IN NON-SATURATED PIXEL POSITION (Xu, Yu) AND COMPENSATION PIXEL VALUES (Rcf, Gcf, Bcf) IN SATURATED PIXEL POSITION (Xc, Yc) ARE CALCULATED
(1) IN THE CASE OF NON-SATURATED PIXEL (Xu, Yu),
Ruf = (Ru / Dmax) × 255
Guf = (Gu / Dmax) × 255
Buf = (Bu / Dmax) × 255
(1) IN THE CASE OF SATURATED PIXEL (Xc, Yc),
Rcf = (Rcq / Dmax) × 255
Gcf = (Gcq / Dmax) × 255
Bcf = (Bcq / Dmax) × 255
S6

FIG. 9

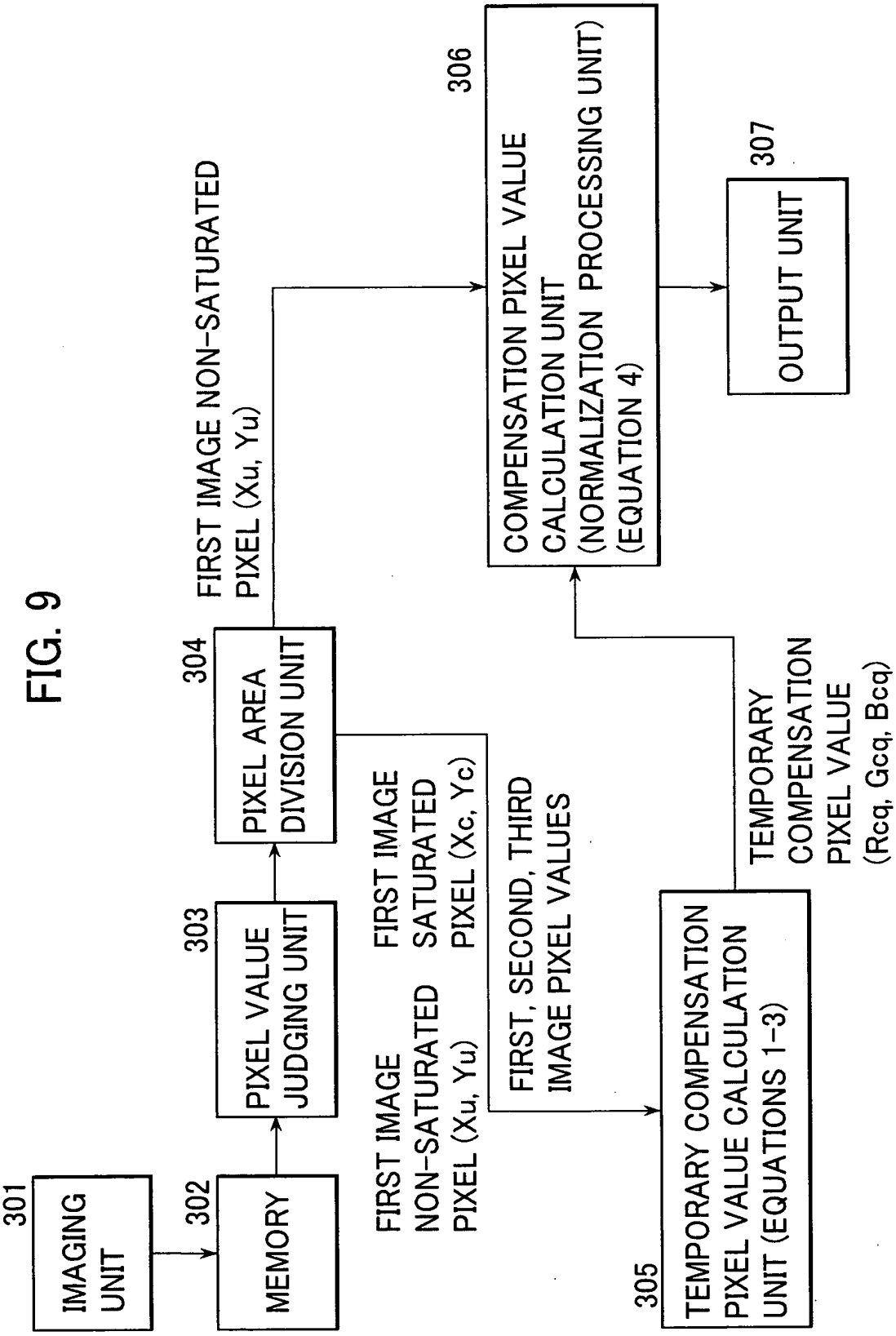

301
IMAGING UNIT
302
MEMORY
303
PIXEL VALUE JUDGING UNIT
304
PIXEL AREA DIVISION UNIT
FIRST IMAGE NON-SATURATED PIXEL (Xu, Yu)
FIRST IMAGE NON-SATURATED PIXEL (Xu, Yu)
FIRST IMAGE SATURATED PIXEL (Xc, Yc)
FIRST, SECOND, THIRD IMAGE PIXEL VALUES
305
TEMPORARY COMPENSATION PIXEL VALUE CALCULATION UNIT (EQUATIONS 1-3)
TEMPORARY COMPENSATION PIXEL VALUE (Rcq, Gcq, Bcq)
306
COMPENSATION PIXEL VALUE CALCULATION UNIT (NORMALIZATION PROCESSING UNIT) (EQUATION 4)
307
OUTPUT UNIT

FIG. 10

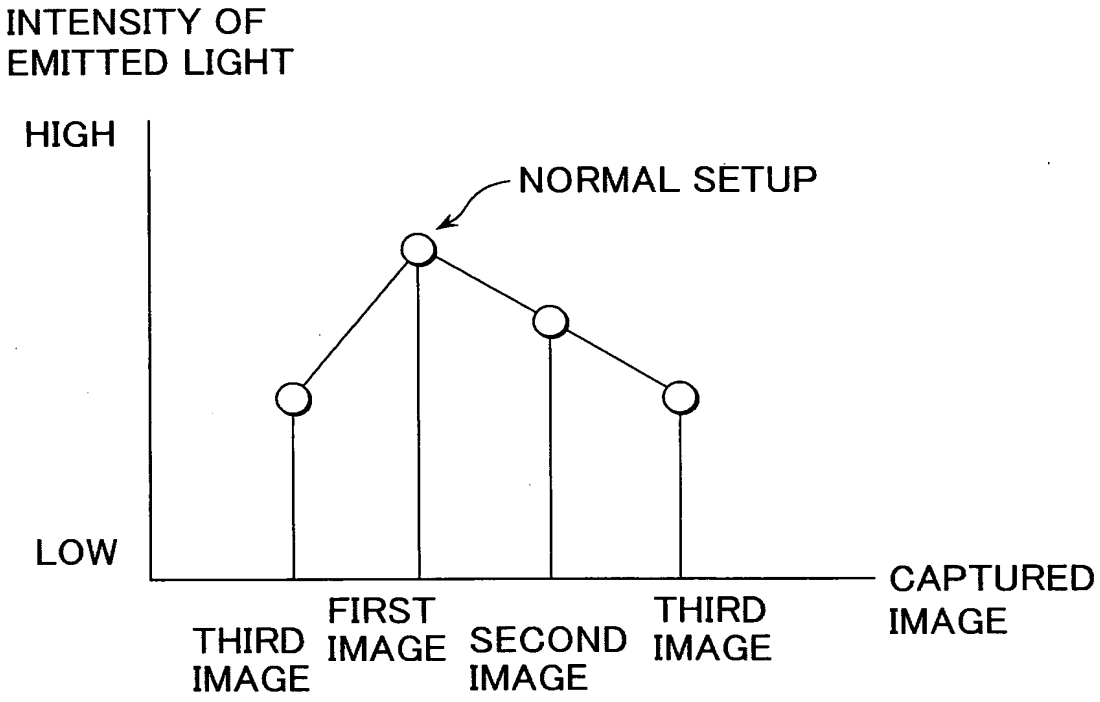

INTENSITY OF EMITTED LIGHT
HIGH
LOW
NORMAL SETUP
CAPTURED IMAGE
THIRD IMAGE
FIRST IMAGE
SECOND IMAGE
THIRD IMAGE

FIG. 11

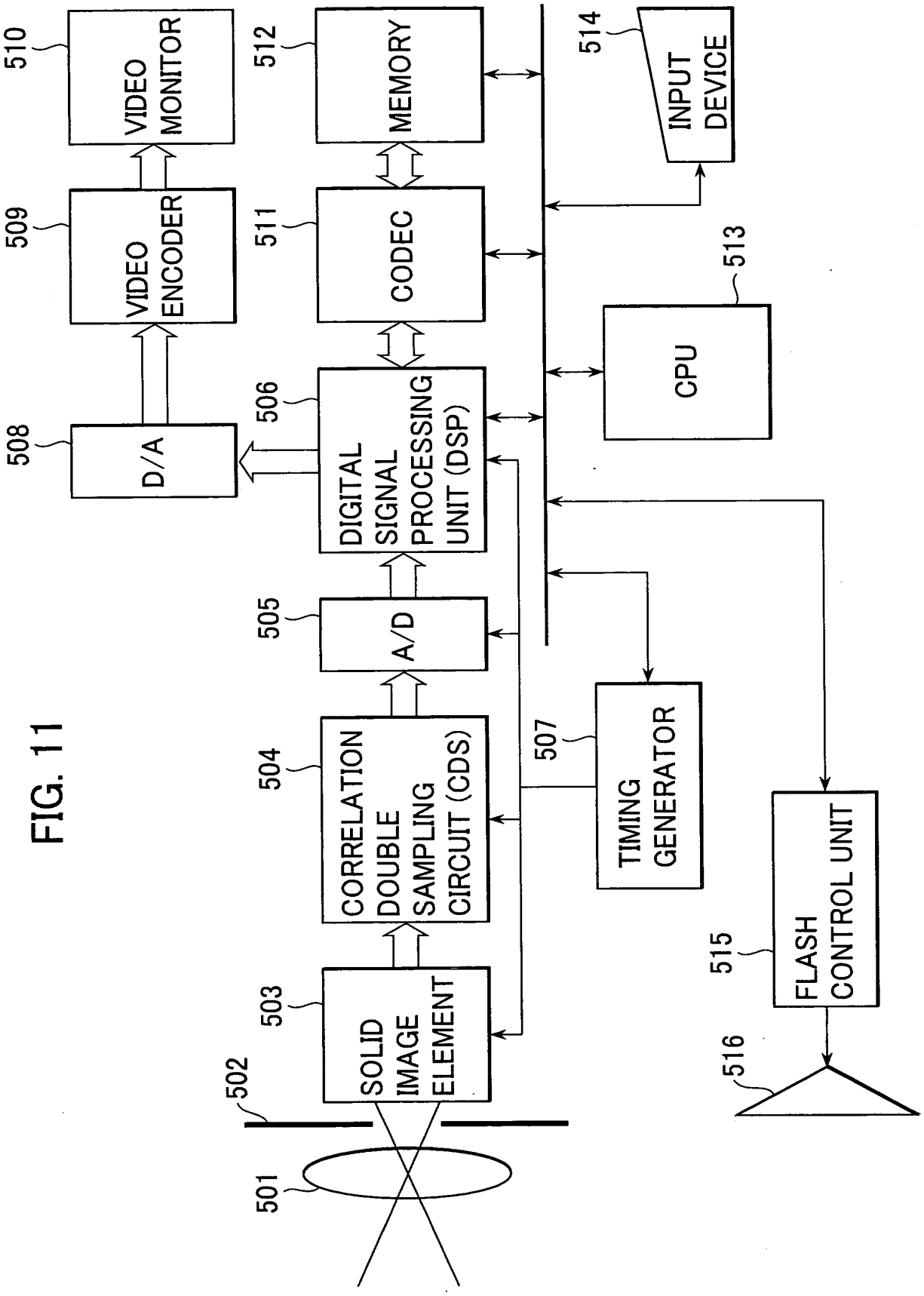

501
502
503
SOLID IMAGE ELEMENT
504
CORRELATION DOUBLE SAMPLING CIRCUIT (CDS)
505
A/D
506
DIGITAL SIGNAL PROCESSING UNIT (DSP)
507
TIMING GENERATOR
508
D/A
509
VIDEO ENCODER
510
VIDEO MONITOR
511
CODEC
512
MEMORY
513
CPU
514
INPUT DEVICE
515
FLASH CONTROL UNIT
516

FIG. 12

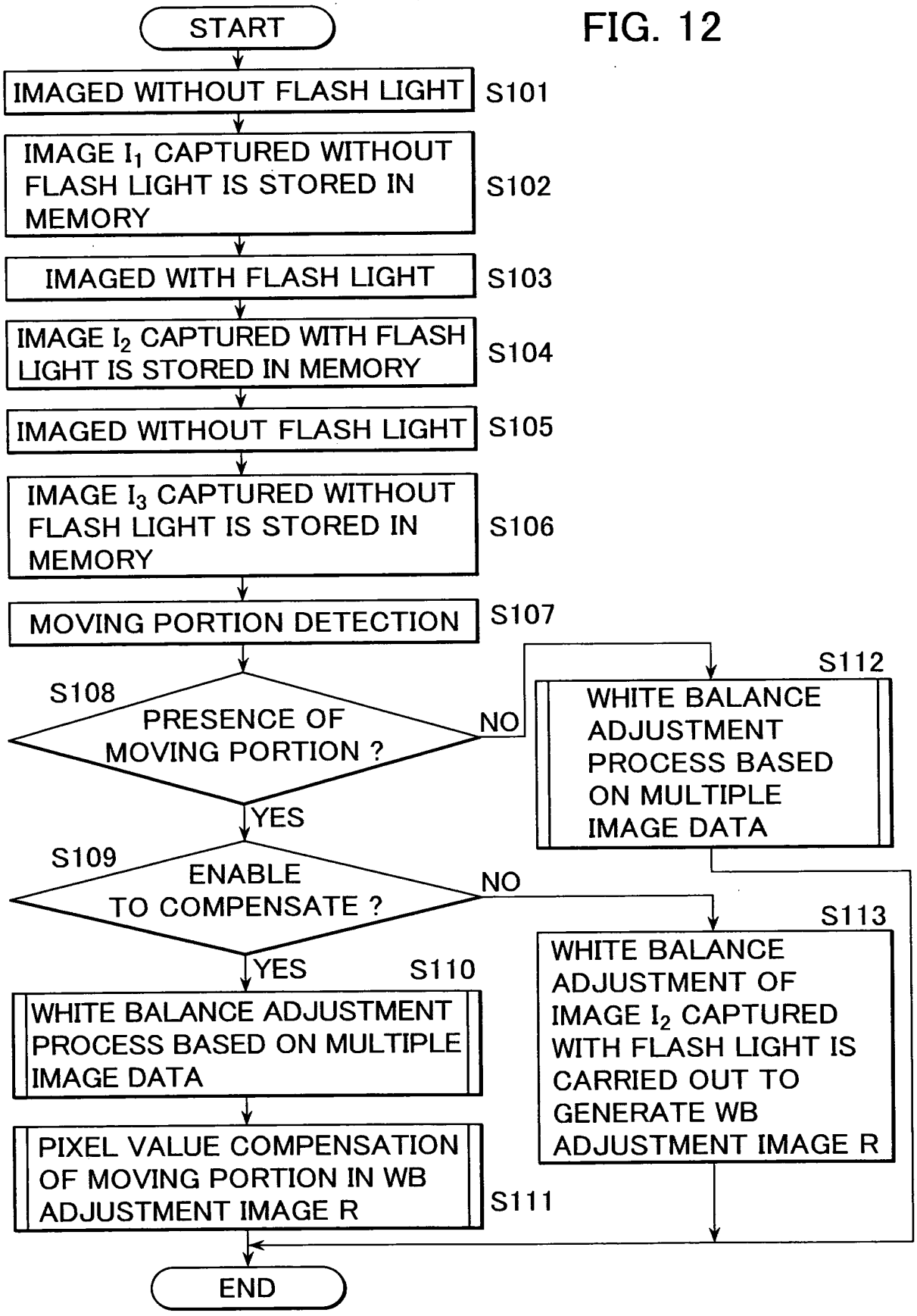
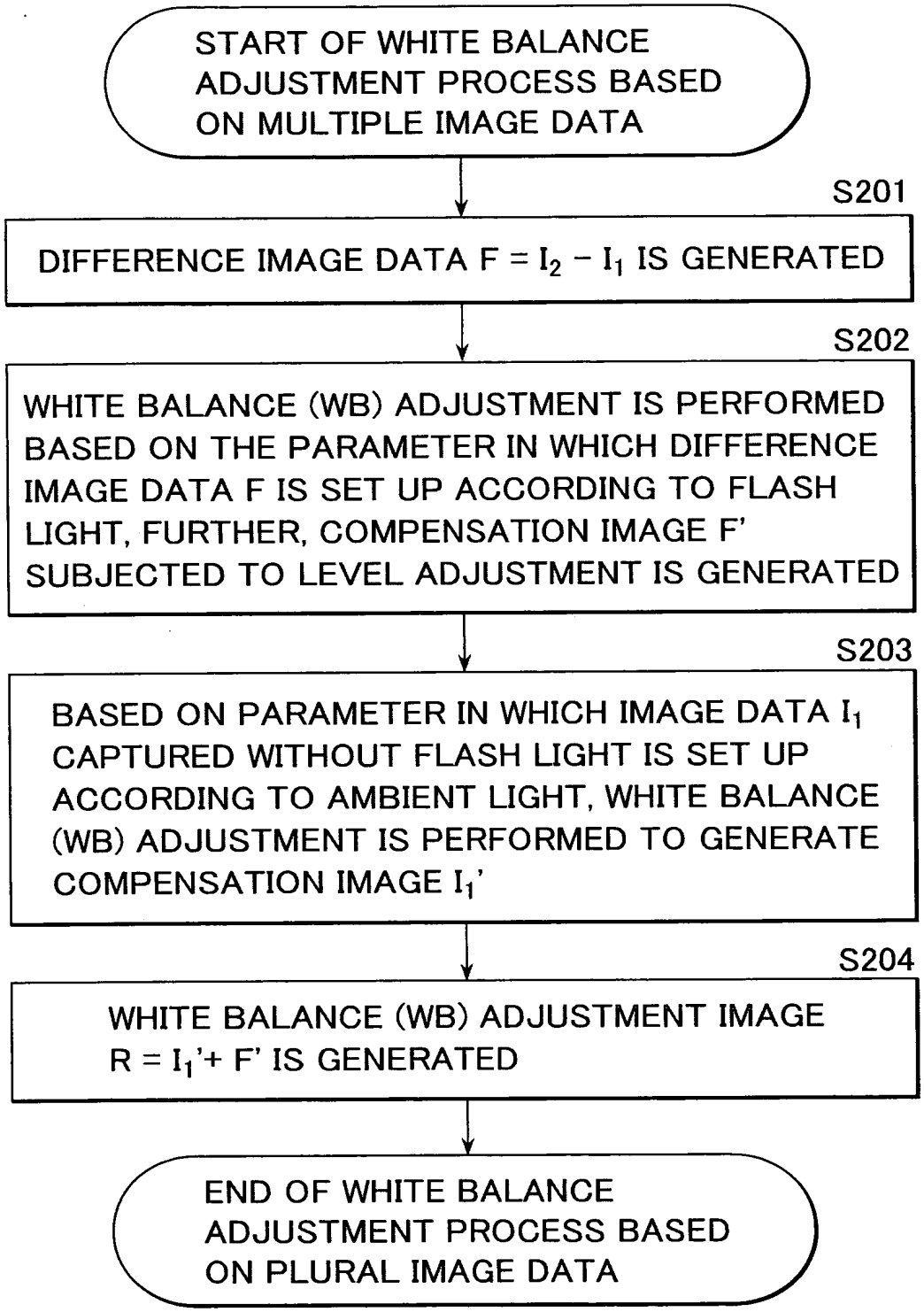

START
IMAGED WITHOUT FLASH LIGHT
S101
IMAGE I_1 CAPTURED WITHOUT FLASH LIGHT IS STORED IN MEMORY
S102
IMAGED WITH FLASH LIGHT
S103
IMAGE I_2 CAPTURED WITH FLASH LIGHT IS STORED IN MEMORY
S104
IMAGED WITHOUT FLASH LIGHT
S105
IMAGE I_3 CAPTURED WITHOUT FLASH LIGHT IS STORED IN MEMORY
S106
MOVING PORTION DETECTION
S107
S108
PRESENCE OF MOVING PORTION ?
NO
YES
S112
WHITE BALANCE ADJUSTMENT PROCESS BASED ON MULTIPLE IMAGE DATA
S109
ENABLE TO COMPENSATE ?
NO
YES
S113
WHITE BALANCE ADJUSTMENT OF IMAGE I_2 CAPTURED WITH FLASH LIGHT IS CARRIED OUT TO GENERATE WB ADJUSTMENT IMAGE R
S110
WHITE BALANCE ADJUSTMENT PROCESS BASED ON MULTIPLE IMAGE DATA
PIXEL VALUE COMPENSATION OF MOVING PORTION IN WB ADJUSTMENT IMAGE R
S111
END

FIG. 13


START OF WHITE BALANCE ADJUSTMENT PROCESS BASED ON MULTIPLE IMAGE DATA
S201
DIFFERENCE IMAGE DATA F = $I_2 - I_1$ IS GENERATED
S202
WHITE BALANCE (WB) ADJUSTMENT IS PERFORMED BASED ON THE PARAMETER IN WHICH DIFFERENCE IMAGE DATA F IS SET UP ACCORDING TO FLASH LIGHT, FURTHER, COMPENSATION IMAGE F' SUBJECTED TO LEVEL ADJUSTMENT IS GENERATED
S203
BASED ON PARAMETER IN WHICH IMAGE DATA I_1 CAPTURED WITHOUT FLASH LIGHT IS SET UP ACCORDING TO AMBIENT LIGHT, WHITE BALANCE (WB) ADJUSTMENT IS PERFORMED TO GENERATE COMPENSATION IMAGE I_1'
S204
WHITE BALANCE (WB) ADJUSTMENT IMAGE R = I_1'+ F' IS GENERATED
END OF WHITE BALANCE ADJUSTMENT PROCESS BASED ON PLURAL IMAGE DATA

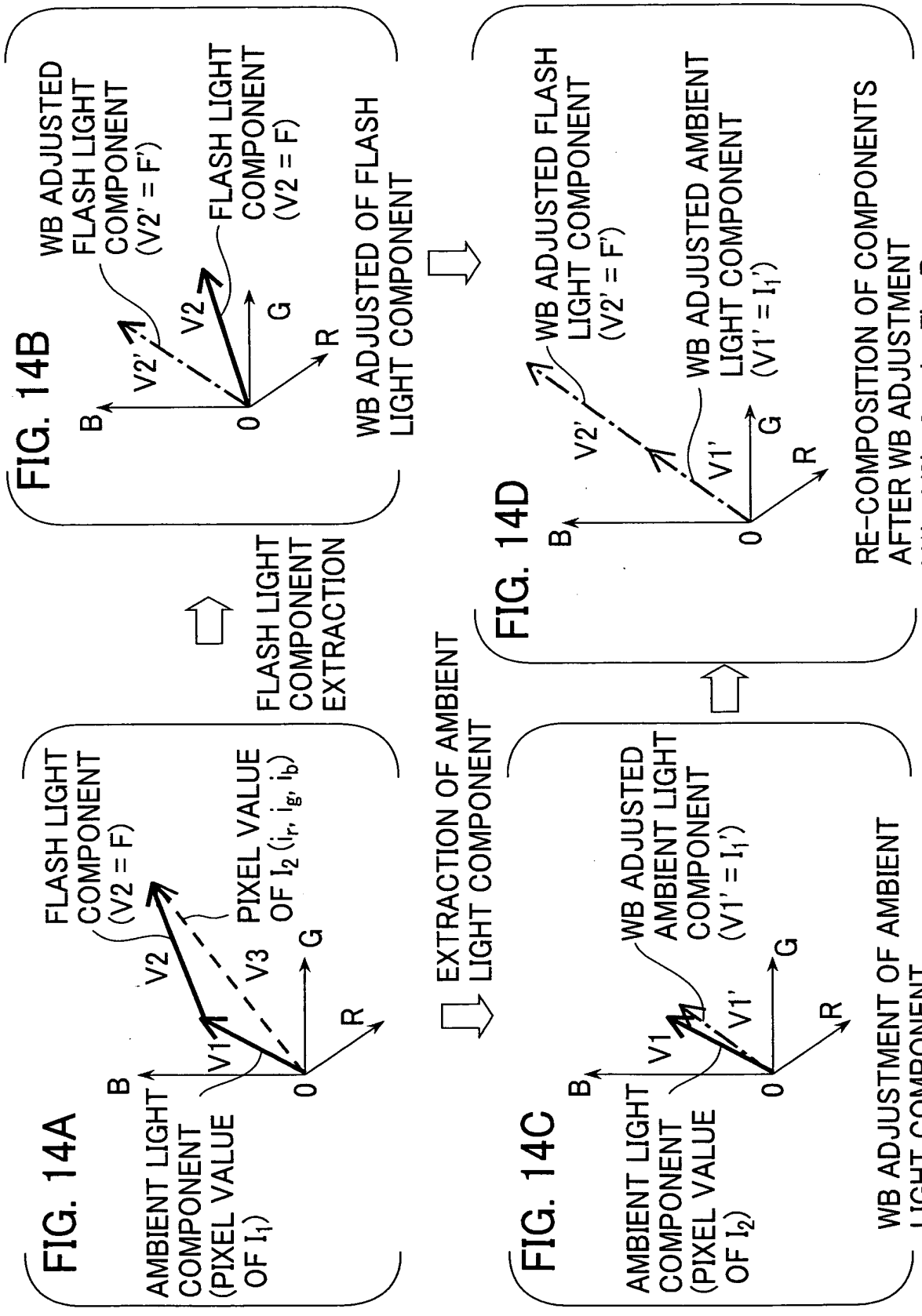


FIG. 14A
AMBIENT LIGHT COMPONENT (PIXEL VALUE OF I_1)
FLASH LIGHT COMPONENT (V2 = F)
PIXEL VALUE OF I_2 (i_r, i_g, i_b)
V1
V2
V3
B
G
R
0
FLASH LIGHT COMPONENT EXTRACTION
FIG. 14B
WB ADJUSTED FLASH LIGHT COMPONENT (V2' = F')
FLASH LIGHT COMPONENT (V2 = F)
WB ADJUSTED OF FLASH LIGHT COMPONENT
EXTRACTION OF AMBIENT LIGHT COMPONENT
FIG. 14C
AMBIENT LIGHT COMPONENT (PIXEL VALUE OF I_2)
WB ADJUSTED AMBIENT LIGHT COMPONENT ($V1' = I_1'$)
WB ADJUSTMENT OF AMBIENT LIGHT COMPONENT
FIG. 14D
WB ADJUSTED FLASH LIGHT COMPONENT (V2' = F')
WB ADJUSTED AMBIENT LIGHT COMPONENT ($V1' = I_1'$)
RE-COMPOSITION OF COMPONENTS AFTER WB ADJUSTMENT
V1' + V2' = I_1' + F' = R

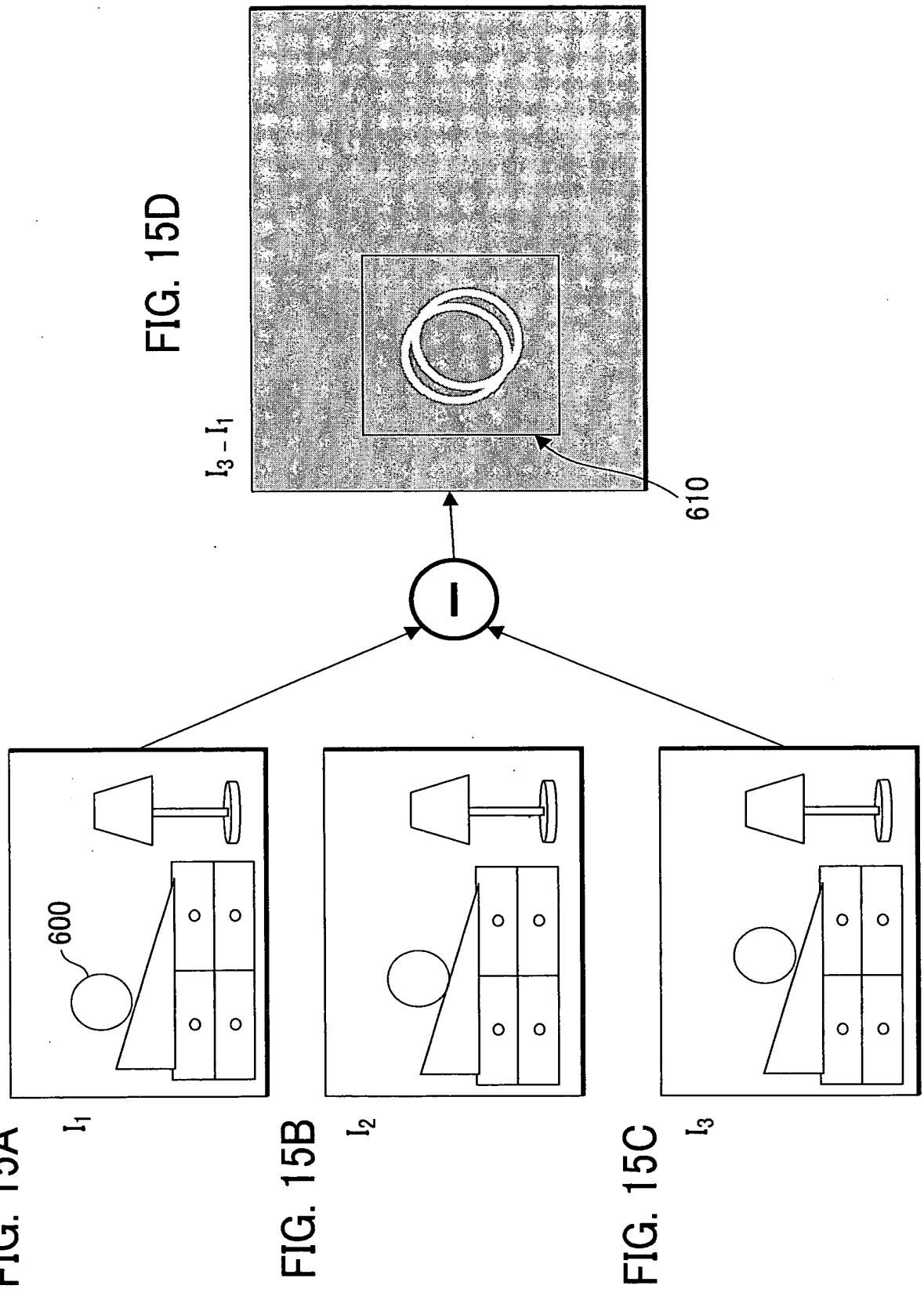


FIG. 15A

FIG. 15B

FIG. 15C

FIG. 15D

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FIG. 16

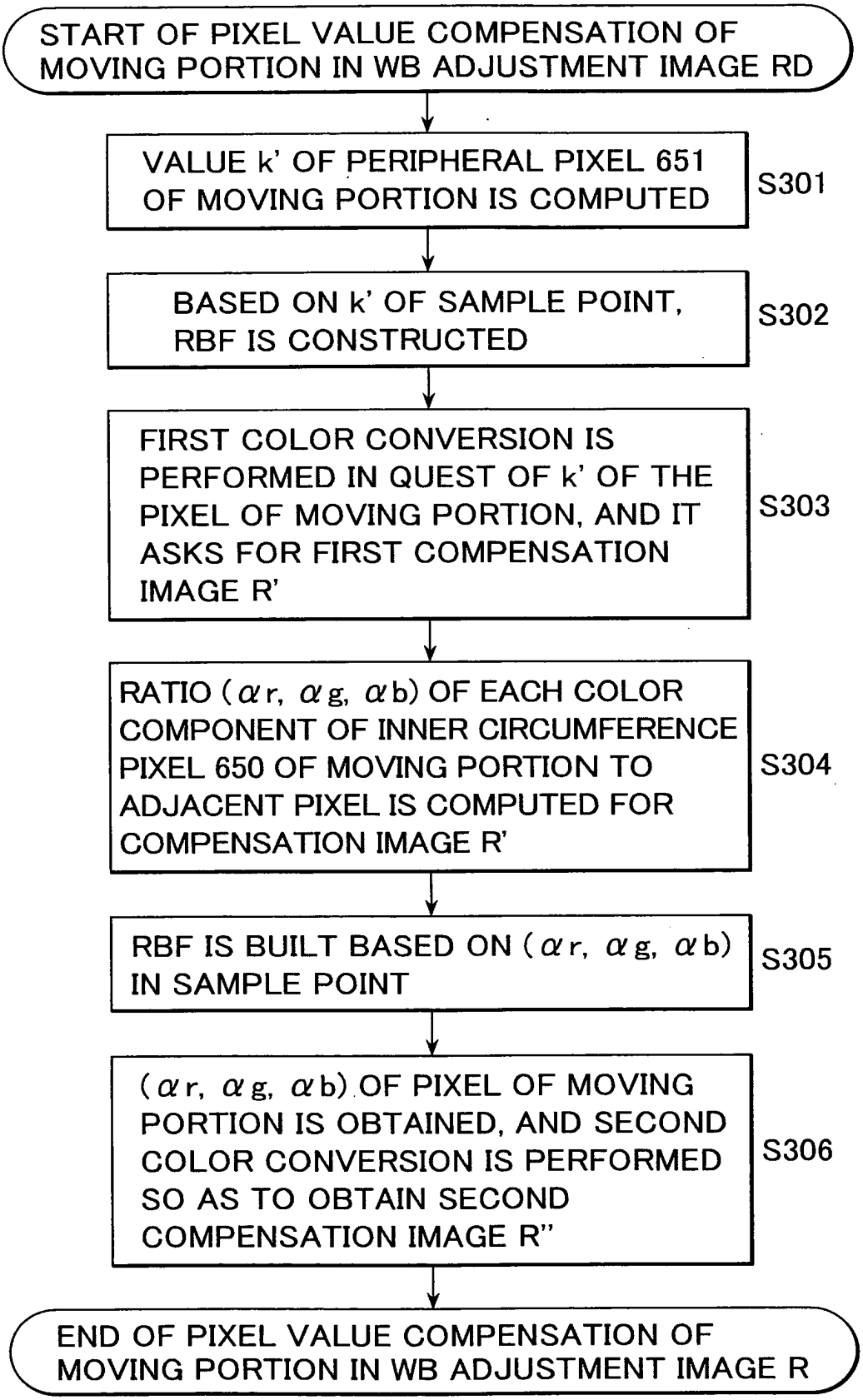
START OF PIXEL VALUE COMPENSATION OF MOVING PORTION IN WB ADJUSTMENT IMAGE RD
VALUE k' OF PERIPHERAL PIXEL 651 OF MOVING PORTION IS COMPUTED
S301
BASED ON k' OF SAMPLE POINT, RBF IS CONSTRUCTED
S302
FIRST COLOR CONVERSION IS PERFORMED IN QUEST OF k' OF THE PIXEL OF MOVING PORTION, AND IT ASKS FOR FIRST COMPENSATION IMAGE R'
S303
RATIO (αr, αg, αb) OF EACH COLOR COMPONENT OF INNER CIRCUMFERENCE PIXEL 650 OF MOVING PORTION TO ADJACENT PIXEL IS COMPUTED FOR COMPENSATION IMAGE R'
S304
RBF IS BUILT BASED ON (αr, αg, αb) IN SAMPLE POINT
S305
(αr, αg, αb) OF PIXEL OF MOVING PORTION IS OBTAINED, AND SECOND COLOR CONVERSION IS PERFORMED SO AS TO OBTAIN SECOND COMPENSATION IMAGE R"
S306
END OF PIXEL VALUE COMPENSATION OF MOVING PORTION IN WB ADJUSTMENT IMAGE R

FIG. 17

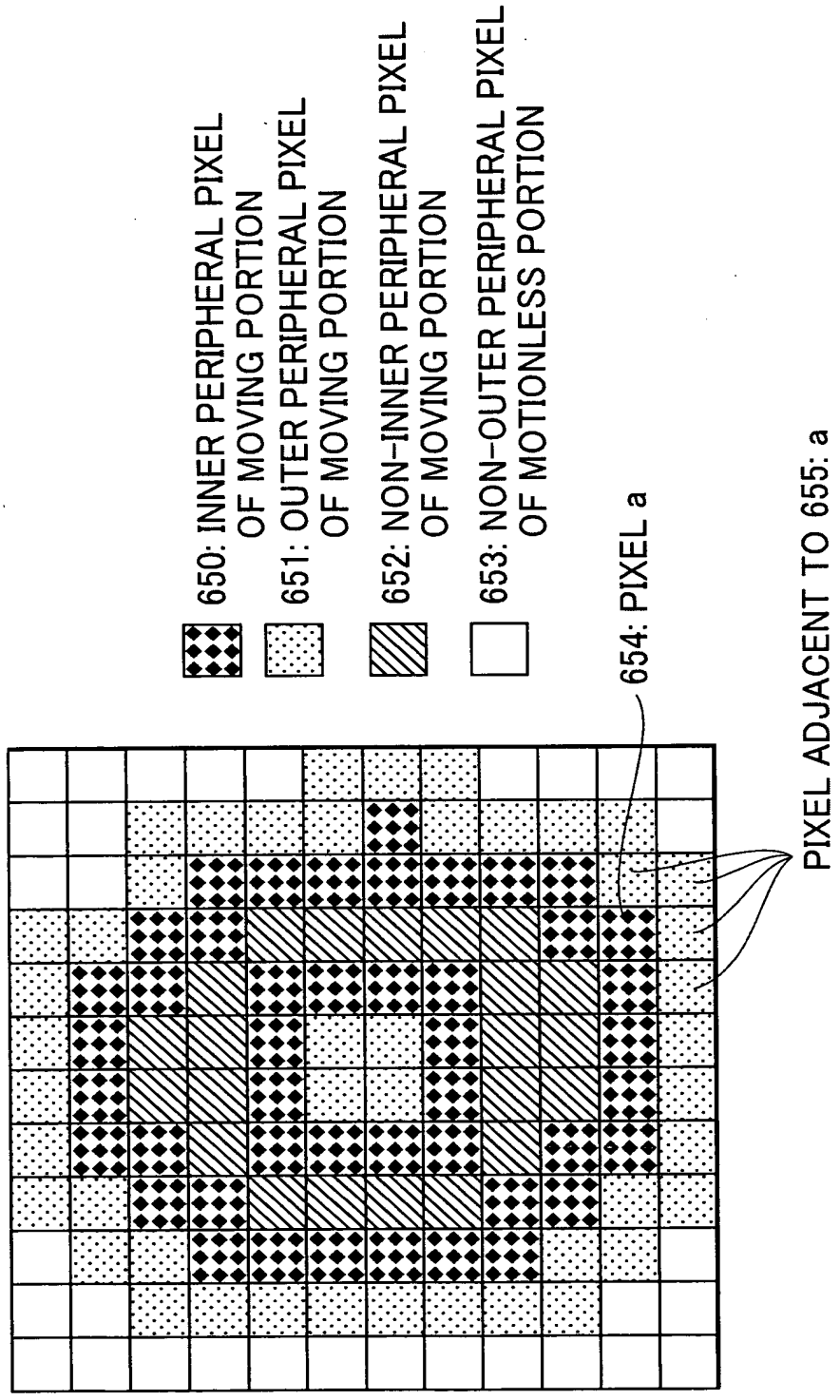
650: INNER PERIPHERAL PIXEL OF MOVING PORTION
651: OUTER PERIPHERAL PIXEL OF MOVING PORTION
652: NON-INNER PERIPHERAL PIXEL OF MOVING PORTION
653: NON-OUTER PERIPHERAL PIXEL OF MOTIONLESS PORTION
654: PIXEL a
PIXEL ADJACENT TO 655: a

FIG. 18

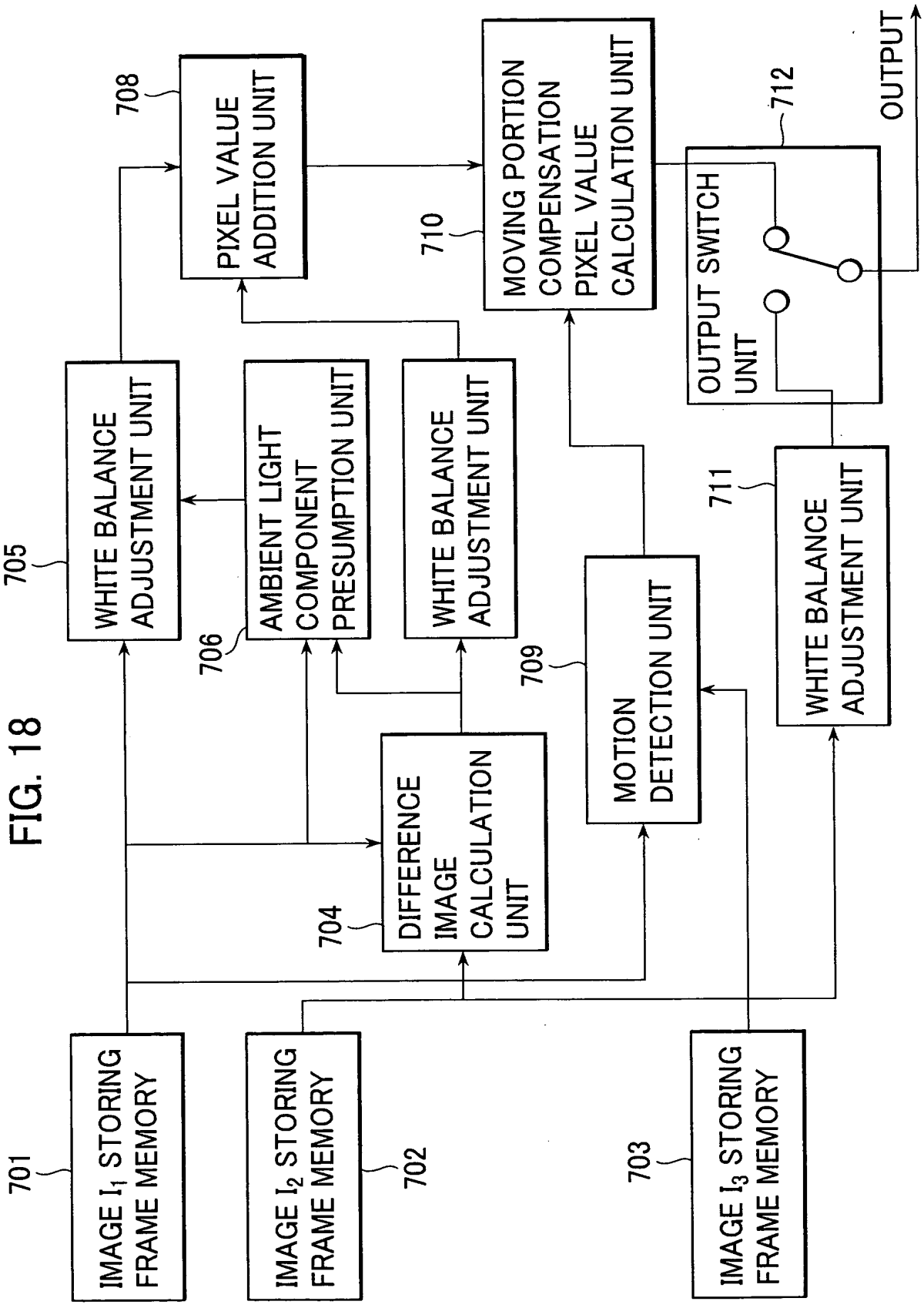
701
IMAGE I_1 STORING FRAME MEMORY
702
IMAGE I_2 STORING FRAME MEMORY
703
IMAGE I_3 STORING FRAME MEMORY
704
DIFFERENCE IMAGE CALCULATION UNIT
705
WHITE BALANCE ADJUSTMENT UNIT
706
AMBIENT LIGHT COMPONENT PRESUMPTION UNIT
708
PIXEL VALUE ADDITION UNIT
709
MOTION DETECTION UNIT
710
MOVING PORTION COMPENSATION PIXEL VALUE CALCULATION UNIT
711
WHITE BALANCE ADJUSTMENT UNIT
712
OUTPUT SWITCH UNIT
WHITE BALANCE ADJUSTMENT UNIT
OUTPUT

FIG. 19

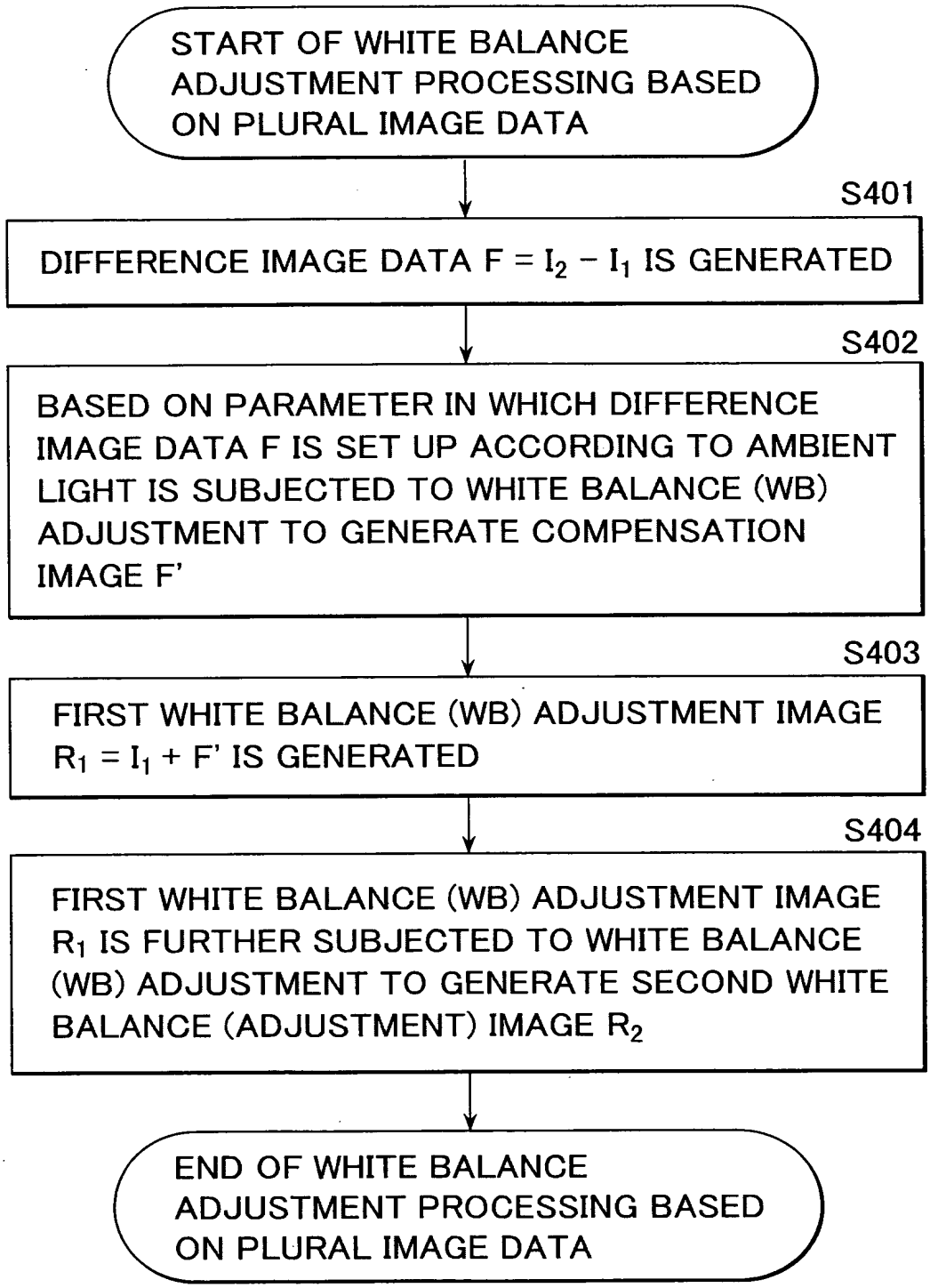
START OF WHITE BALANCE ADJUSTMENT PROCESSING BASED ON PLURAL IMAGE DATA
S401
DIFFERENCE IMAGE DATA F = $I_2 - I_1$ IS GENERATED
S402
BASED ON PARAMETER IN WHICH DIFFERENCE IMAGE DATA F IS SET UP ACCORDING TO AMBIENT LIGHT IS SUBJECTED TO WHITE BALANCE (WB) ADJUSTMENT TO GENERATE COMPENSATION IMAGE F'
S403
FIRST WHITE BALANCE (WB) ADJUSTMENT IMAGE $R_1 = I_1 + F'$ IS GENERATED
S404
FIRST WHITE BALANCE (WB) ADJUSTMENT IMAGE R_1 IS FURTHER SUBJECTED TO WHITE BALANCE (WB) ADJUSTMENT TO GENERATE SECOND WHITE BALANCE (ADJUSTMENT) IMAGE R_2
END OF WHITE BALANCE ADJUSTMENT PROCESSING BASED ON PLURAL IMAGE DATA

FIG. 20

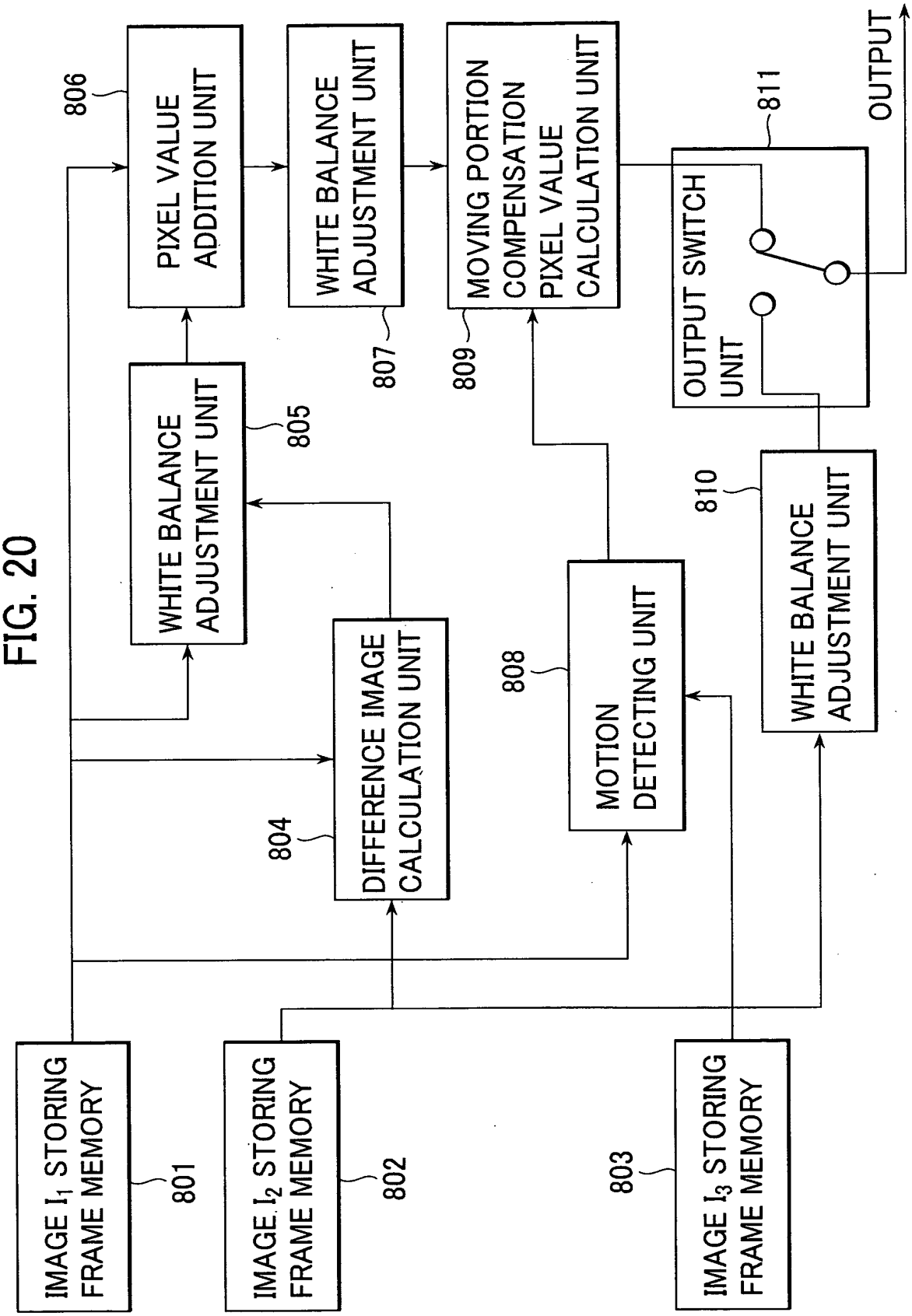
IMAGE I_1 STORING FRAME MEMORY
801
IMAGE I_2 STORING FRAME MEMORY
802
IMAGE I_3 STORING FRAME MEMORY
803
DIFFERENCE IMAGE CALCULATION UNIT
804
WHITE BALANCE ADJUSTMENT UNIT
805
PIXEL VALUE ADDITION UNIT
806
WHITE BALANCE ADJUSTMENT UNIT
807
MOTION DETECTING UNIT
808
MOVING PORTION COMPENSATION PIXEL VALUE CALCULATION UNIT
809
WHITE BALANCE ADJUSTMENT UNIT
810
OUTPUT SWITCH UNIT
811
OUTPUT